NASA Innovative Advanced Concepts

3D Photocatalytic Air Processor for Dramatic Reduction of Life Support Mass and Complexity

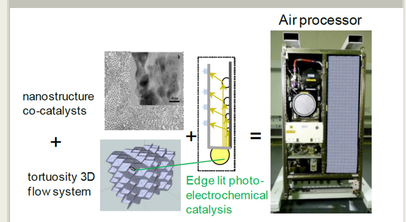
Completed Technology Project (2015 - 2017)

Project Introduction

The abundant high-energy light in space (with wavelengths as low as 190 nm, compared to 300 nm on Earth) makes the TiO2 co-catalyst an ideal approach for sustainable air processing to generate O2, without consuming any thermal or electrical energy. The combination of novel photoelectrochemistry and 3-dimensional design allows tremendous mass savings, hardware complexity reduction, increases in deployment flexibility and removal efficiency. Operation at near ambient temperature and pressure is inherently safer for the crew. The potential exists for the high tortousity photoelectrocatalytic air processor design to achieve more than an order of magnitude in combined mass/volume/power/cooling resource savings.The proposed work will demonstrate these drastic reductions in comparison to current technology with delivery of high-tortuosity device components allowed by advanced manufacturing (potentially in space) at the end of the proposed work.

Anticipated Benefits

The abundant light in space (with wavelengths of 190 nm vs. 300 nm on Earth) makes the TiO2 co-catalyst an attractive choice for sustainable air processing to generate O2, without consuming any thermal or electrical energies. The combination of novel photoelectrochemistry and 3D design allows tremendous mass savings, hardware complexity reduction, deployment flexibility and removal efficiency increases. Due to its near ambient temperature and pressure operation, the HTPEC air processor design is inherently safer and can potentially achieve at least two orders of magnitude mass and power savings, and enable compact processors for spacecraft. The 3D fabrication for spacecraft life support and ISRU applications, potentially in space, enables the sustainable space exploration. The proposed technology also has significant impact on terrestrial applications in emission gas reduction pertinent to automobile industry and power plants, and a way of chemical energy storage for off-grid power. The Phase I studies have attracted significant interests ranging from the 3D printing materials to the artificial photosynthesis approach from Silicon Valley industrials: research pioneer PARC, equipment manufacture Applied Materials Inc (POC: Dr. Hou T Ng, Hou_Ng@amat.com, chief Technologist office), optics company CRI (Phase II team member), start-up company MolyWorks (support letter attached) are all onboard to support our work at the different levels in market and technology advancement.



Graphic Depiction of 3D Photocatalytic Air Processor

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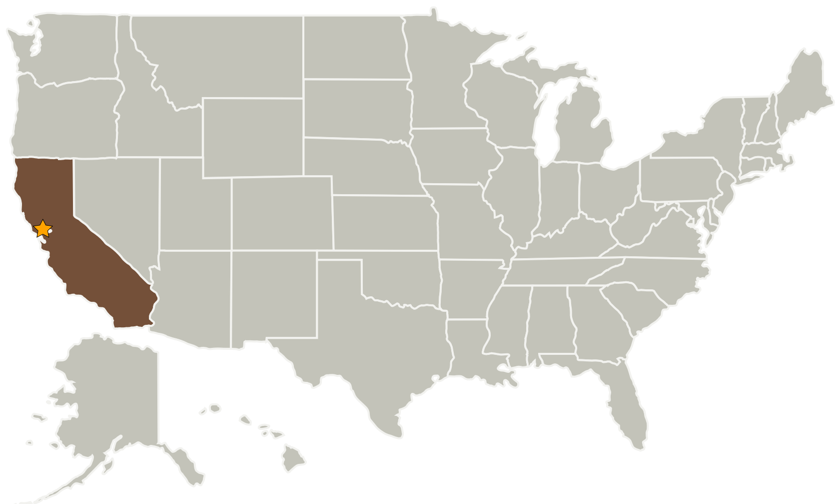
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Ames Research Center(ARC)	Lead Organization	NASA Center	Moffett Field, California
Crystal Research, Inc.	Supporting Organization	Industry	Fremont, California
Palo Alto Research Center(PARC)	Supporting Organization	Industry	Palo Alto, New Mexico
University of California-Berkeley(Berkeley)	Supporting Organization	Academia	Berkeley, California

Primary U.S. Work Locations
California

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Ames Research Center (ARC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Bin Chen

Co-Investigators:

Kenneth C Cheung
Darrell L Jan
John E Hogan

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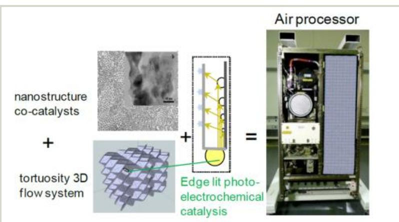
Project Transitions

July 2015: Project Start

June 2017: Closed out

Closeout Link: https://www.nasa.gov/feature/3d-photocatalytic-air-processor-for-dramatic-reduction-of-life-support-mass-and-complexity

Images



Project Image
Graphic Depiction of 3D Photocatalytic Air Processor
(https://techport.nasa.gov/image/102171)

Links

NASA.gov Feature Article
(https://www.nasa.gov/feature/3d-photocatalytic-air-processor-for-dramatic-reduction-of-life-support-mass-and-complexity)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.4 Manufacturing
    └ TX12.4.1 Manufacturing Processes

Target Destinations

The Sun, The Moon, Mars